HOW
TO
REPAIR
THE
APPLE
COMPUTER

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How to Repair
The Apple* Computer

Volume 1

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Introduction

Welcome to the world of computer repair. You're on the road to saving hundreds of dollars by performing your own diagnostics and repair to your computer.

For the record, APPLE is a trademark of APPLE COMPUTER, INC. of which we have no affiliation. Henceforth in this guide, we will call the APPLE II — the computer, and the APPLE II PLUS — the computer plus.

Many that buy this manual will wonder why disk software is not included. In answer, let us ask you one question. How can you load disk software if the computer is not working?

Disk software for testing individual sections of the computer are fine if the computer is partially working and will permit such a test. In most cases, the computer will not load the software if it is not working properly.

With repair rates soaring these days, and outrageous repair bills being charged for even simple computer repairs, this guide can save you money.

If you repair your computer just once using this manual, you will have saved more then enough to pay for the manual itself.

Remember when television operated with tubes? When the TV broke down, we labeled the tubes, removed them from the set, carted them down to the local supermarket or drug store, and tested them on a tube tester.

We then bought a replacement tube for the one(s) found bad, replaced all the tubes back into the set, and held our breath as we turned the TV back on.

AHHHH! it works! We then proceeded to pat ourselves on the back each time the set was turned on

Then one day our new portable TV breaks down and we proceed to open it up to remove the tubes, and what do you know? NO TUBES! How could they make TV sets without tubes.

The age of Transistors was upon us. Little miniature silver cans with wires extending down from then into fiberglass boards. After finally learning the TV repair game, somebody comes along and changes the rules! THANKS A LOT!

At this point many of us gave up electronic repair for much lighter hobbies such as bird watching and stamp collecting. We didn't realize the electronic industry was only fooling us for a brief period of time.

Before we knew it, a new electronic part was introduced to the world known as the INTEGRATED CIRCUIT, more commonly called the IC CHIP or just IC. A miniature rectangular box with metal legs extending down on two sides.

These legs are called pins, and the box is known as CHIP or PACKAGE.

Now you don't need a Ph.D. in electronic engineering to understand IC's, as you can't go inside one and repair it anyway. You can only replace one if it goes bad.

If we count the number of pins on an IC we have its size. Example: a 14 pin IC package will have 14 pins extending down from it, 7 on each side. A 16 pin IC chip will have 16 pins extending down from it, 8 on each side. IC chips come in many sizes, the most popular being 14 pin and 16 pin.

Much like tubes fit into sockets, IC chips can be plugged into sockets also. The main problem is they can be placed into the socket backwards by mistake.

To help prevent this little problem, each IC has a reference marking and a reference point or pin #1. Figure 1.1 shows typical IC's and where to determine their reference point.

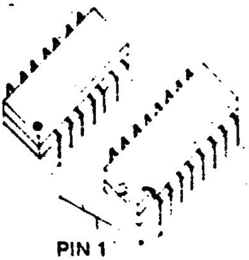

FIG. 1

As a general rule, the manufacturers of IC's place a notch at one end of the IC. From this notch we can find pin #1.

Once we know this, removing and inserting an IC chip into it's socket properly becomes simple.

The only other problem with installing IC's, is bending the pins.

For this reason, when an IC is placed into a socket, always check along the sides of the IC to see that no pins are sticking outside the socket or bent underneath the chip.

Also check to see that the IC is inserted in the proper direction with respect to it's pin #1.

Back when IC's were first used, technicians found it faster and easier to swap out all the IC's in a particular faulty area, rather then perform extensive trouble-shooting. Normally they would replace the chips one by one until the problem was fixed.

Later, trouble-shooting guides were developed. A trouble-shooting guide is a chart that shows what the problem is, and what part(s) to replace.

The technician looked down the chart to find the problem that matched his problem, then replaced the indicated parts on the replacement side of the chart.

Now you're probably saying to yourself, "Any fool can use a trouble-shooting chart!"

You're absolutely correct. Once you familiarize yourself with your computer, you can use the charts supplied in this book for repairs.

While you may run into a few problems that truly require electronic skills, the majority of your computer related problems you will be able to fix yourself.

This manual was written from a non-technical aspect for repairing your computer. We regret that highly technical information is not included, as the majority of computer owners have no technical background.

CHAPTER 1

Getting to Know Your Computer

Your computer or computer plus is constructed of four *major* parts and two *minor* parts.

The *major* parts are:

1. The power supply.
2. The motherboard.
3. The keyboard.
4. The case.

The *minor* parts are:

1. The speaker.
2. The power cable.

You can remove the lid of the case by grasping the lid with both hands at the rear of the case, pulling up on the lid, then sliding it back and away from the case. Place the lid in a safe place. (Right in front of your plastic chewing puppy, who hasn't been fed in the last six hours, is not a safe place.)

Let's examine the different parts of the computer. You should be sitting in front of the computer. Keyboard closest to you.

The power supply.

Looking inside your computer, to the left side, you will see a rectangular metal box. Some are silver and some are gold colored. This box will also have a sticker by Apple, Inc. saying "Power Supply".

The power supply takes electricity from your electrical outlet and converts it into smaller units of power required for the other parts of the computer.

The power cable.

At the rear of the computer at the end of the power supply is a cable going to your electrical outlet. This is the power cable and it is detachable.

Warning:

Never reach into your computer without first turning it off. Even though you probably won't feel anything except heat from the parts, you can severely damage the parts in the computer by handling them with the power on.

A good rule to follow when going inside your computer is to do the following;

1. Turn off the power switch on the computer.
2. Remove the lid of the case.
3. Place one hand for a moment on top of the power supply.
4. Detach the power cable.

The reason for this rule is that several everyday elements around us can cause our bodies to hold a static electrical charge. Like walking across a carpeted area and touching a metal object we might feel a slight shock. This is static electricity and can cause grave damage to IC's. When you touch the top of the power supply, this will eliminate any static charge you may be carrying, and in most cases you don't even know it.

Once you have touched the power supply, you can detach the power cable. This is done so that you don't accidently turn the power switch back on while working inside the computer. That being said, let's examine the computer a little further.

The motherboard.

At the opposite end of the power supply (away from the power cable and switch end) is a banded set of colored wires which come out of the power supply and plug into a big green board. This big board is the motherboard. It extends far underneath the keyboard at one end, and the other end is of course where we installed all those expensive little add on boards.

Looking at the parts on the motherboard, you will see a lot of IC's all over it. AHA! Now you know why we told you about IC's. There are about 85 IC's on the motherboard, which we will examine more closelv later.

Notice how Apple, Inc. has made it simple for you to remove and replace the IC's by putting them into sockets. How nice of them.

Actually they did this to help service centers repair your computer easier and faster. However, it let's us all take advantage of easier and faster repeirs.

One more note about the motherboard at this point, is that the slots in the rear of the computer are labeled on the motherboard itself, between the rear of the case and the back edge of the slot. Slot 0 will be to the most left, thru slot 7 to the most right.

The keyboard.

The keyboard is most obvious to the casual observer. What is not so obvious is that the keyboard is attached to the motherboard thru a colored ribbon cable. If you look underneath the keyboard inside the computer, you can see the ribbon cable.

The case.

The computer case is actually made up of three parts, 1-the lid that you removed to look inside the computer, 2-the housing, which is the off-white plastic part the lid attaches to, and 3-the metal bottom plate.

The speaker.

Looking underneath the keyboard again, to the left hand side. You will see a small speaker attached to the motherboard. It is in fact glued to the motherboard. You will also notice two wires coming out from the speaker, going directly across the motherboard and plugging into the motherboard on the right hand side.

In the next chapter we will go through taking the computer apart and putting it back together. However quite briefly the assembly is as follows:

1. The power supply attaches to the metal bottom plate of the case by four screws. We have already seen that it attaches to the motherboard thru a connector.
2. The motherboard is attached to the metal bottom plate and is being held slightly off the metal plate by plastic stand-offs. (In case of newer computers, with four screws and a bar.)
3. The keyboard is attached to the housing of the case with four screws, and as we've seen, to the motherboard, thru a ribbon cable.
4. The housing section of the case attaches to the metal bottom plate with 10 screws.

CHAPTER 2

Taking your computer apart:

The best thing about your computer is that it comes apart and reassembles very easily. Even if you don't want to get into trouble shooting on the major parts, if you know how to remove and replace the major part that becomes defective, you can save yourself some of that high labor cost.

The following will be a step by step instruction guide to disassemble and reassemble your computer. We suggest you read through this chapter completely first, then go back over and follow the instructions. If you familiarize yourself with the computer and the step by step instructions first, taking the computer apart and putting it back together again will go much faster and easier.

One note at this point is not to be afraid of your computer. It won't bite and if you follow the instructions, you're not going to hurt the computer.

Before you start to take the computer apart, you will want to get the following items:

1. A pad of paper and a pencil, for taking notes.
2. One phillips head screwdriver.
3. One straight slot screwdriver on an IC puller. (an IC puller can be bought for about $2.00 at any well stocked electronics store.)
4. A small dish or cup, for holding removed screws.
5. A large towel or something to cushion and protect the face of the computer when it's turned upside down.

It is most advisable to disassemble and reassemble the computer on a flat table surface and not a carpeted area. As stated in the previous chapter, the IC's may fail if subjected to static charge, and a carpet can cause a static charge.

To take the computer apart:

1. First turn power off on the computer and any accessories you may have. (Do not detach the power cable yet.)
2. Remove the lid from the case by grasping the lid with both hands in the back, pulling up until the plastic catches release, then sliding the lid back and away from the computer. Store the lid in a safe place.
3. Place one hand on top of the power supply just momentarily, then detach the power cable. You will notice the power cable is keyed. Unless you try to force it back on with a sledge hammer. you can't reattach it the wrong way.
4. Take a good look at any small boards that are plugged into the slots of the motherboard. Write down on your pad of paper which boards go into which slots.

Also notice any cables that may be going to these boards. Most cables are keyed or have a red line on one edge. Other ribbon cables are color coded. Take notes as to which end of the cable is closest to the keyboard. Make sure you will be able to attach the cables and place the boards in the correct slots, from your notes.

5. Detach all cables from the boards in the computer. Also detach the monitor cable and/or the modulator cable (if you have one).

At this point there should be no cables at all attached to the computer.

6. Remove any and all boards that may be plugged into slots on the motherboard, and place them in a safe place.

7. Place the towel on the flat surface and turn the computer upside down on the towel.

You should now be looking at the metal bottom plate of the computer.

8. There are ten and only ten phillips head screws that you are going to remove from the botton plate.

A. The first two screws are located at the back edge of the bottom plate, one on each side, behind the rubber feet. There are other screws directly in line with the rubber feet DO NOT REMOVE THOSE! Remove only the two sorews located behind the rubber feet.
B. Next, there are four screws to remove. On both sides of the bottom plate, along the edge of the plate, are two screws. These screws are outside the oval hole patterns cut into the bottom plate. Remove these four screws.
C. Last, there are four phillips head screws along the front edge of the bottom plate, located in half circular notches. Remove these four screws.

Be sure to place these screws in a dish or cup so they won't get lost.

Before going on to the next step, let's examine the bottom plate a little further.

On the right side of the bottom plate are four silver colored phillips head screws. These screws hold the power supply to the bottom plate. You don't need to remove these screws now, but if you ever do, be sure to hold the power supply with one hand as you remove those four screws.

The rest of the screws on the bottom plate are to hold the motherboard. There is no need to ever remove these screws, as they are attached to plastic stand-offs, and the motherboard is removed from the top of the bottom plate. This will become clearer as we proceed further with taking the computer apart.

9. Grasp the bottom plate and housing with both hands, holding the two sections together, and turn the computer face-side-up again.

10. Look inside the computer, on the motherboard, between the slots and the rear of the housing.

Either you will see four phillips head screws or you will see two white prongs protruding up through the motherboard. (One at the left hand corner, and one at about the center of the back edge.)

If you see the two white prongs and not four phillips head screws, go to step 11.

If you see the four phillips head screws, then you have a newer computer. Now look to see if a metal plate is attached to the back of the housing; inside the computer, that goes down underneath the motherboard. It will be silver in color. If you don't see such a plate go to step 11.

The metal plate is part of the RFI shielding, and the plate will stop you from lifting the housing away from the bottom plate. Loosen the four phillips head screws just enough so you can't pull them out, but will allow movement of the silver plate.

11. Should you be using a TV modulator for video, you will want to remove the cable that attaches to the motherboard. First check orientation of the cable (black wire closest to the modulator) then unplug the cable.

12. Now place your hands one on each side of the housing close to the front of the computer (about parallel with the keyboard). Very gently lift up on the front of the housing about three to four inches away from the bottom plate.

Look between the housing you are holding and the bottom plate. There will be a colored ribbon cable going from the keyboard to the motherboard.

Take a close look at how the cable is plugged into the motherboard. Check orientation of which colored wire is at which end of the socket.

Set the housing back down and write the information down for future reference.

13. Now lift the housing back up to the same position as the previous step.

Hold the housing with one hand and use the flat blade screwdriver or IC puller to gently pry up the end of the cable at the motherboard.

Be careful not to pry the socket of the motherboard up. If the socket starts to come up with the connector of the cable, press the connector back down with your thumb and try again.

14. With the cable free, the housing, with the keyboard, can now be lifted away from the bottom plate and put aside. We'll look at it closer later.

Should you have the silver metal plate, mentioned in step 10, you will have to lift the front of the housing and slide it back to release the plate from the motherboard.

Let's take a closer look at the motherboard at this point. You will notice number 1 to 14 labeled in white letters at the front of the board. You will see letters from A thru K labeled on the left side of the board.

This lettering is used to identify part location. Example: IC - C2 is a 74S195 IC. First follow an imaginary line across the board from left to right at location C. You will see the parts are in a row. Now follow an imaginary line from front to back at location 2, again the parts are in a row. Where these two rows intersect is an IC. Both the IC and the motherboard are labeled.

The motherboard is being held down by:

A. Two white stand-offs at the front two corners of the board.
B. One white stand-off at location F8
C. One white stand-off at location J8
D. And either three white stand-offs at the rear edge of the board, or One white stand-off at the right rear corner, and four phillips head screws (depending on the revision of the computer).

The stand-offs serve two purposes. They insulate the motherboard from the metal bottom plate, and provides ease in removing and replacing the board.

15. To remove the motherboard completely:

A. First disconnect the cable connected to the board from the power supply by squeezing the connector. in front and back with thumb and finger, then pull up straight on the connector, not the wires.

   The connector is keyed so it can't be reinstalled the wrong way.

B. Disconnect the connector at location B14 coming from the speaker. Again this is done by lifting up on the connector and not the wires. The orientation of this connector is not important, as it can be reconnected either way.
C. If you have the four phillips head screws at the rear of the board, remove them.
D. Now starting from front to back, press each one of the white stand-offs and pull up gently on the board at the same place. Working from front to rear, when the motherboard clears all the stand-offs, it can be lifted up and away from the bottom plate.

16. To remove the power supply:
A. If step 15 has not been performed to remove the motherboard, disconnect the cable going to the motherboard from the power supply, as explained in step 15A.
B. Turn bottom plate on one side so that you can hold the power supply and bottom plate with one hand, and remove ~~the screws~~ with the other.
C. Remove the four silver colored phillips head screws.
D. The power supply will lift away from the bottom plate.

Very rarely will the speaker go bad in the computer. If for some reason it has to be replaced, as stated in the previous chapter, it is glued in.

It can be pried up with a straight slot screwdriver, and a new speaker can be glued in using super-glue or the like.

The foam piece surrounding the speaker is more for vibration and looks than anything else. We've seen a lot of speakers without foam.

Let us turn our attention now to the housing and keyboard.

17. To remove the keyboard.

A. Turn housing with the keyboard face side down on a towel or padded surface.
B. Remove the four phillips head screws, two on each side of the keyboard.
C. The keyboard will lift up and out away from the housing.

Your keyboard may or may not have a piggyback smaller board connected to it (depending on the revision of the computer). If it does, this is an encoder board. It takes information you type in on the keyboard, and converts it to information for the motherboard.

If you do not have this piggyback board, the encoding parts are on the main keyboard itself.

The encoder board, if you have one, is connected to the main keyboard via two white stand-offs and a 25 pin connector.

The metal pins on the 25 pin connector are very easily bent, so be very careful when trying to remove the encoder board.

18. To remove the encoder board.

A. Squeeze the stand-off at one end and pull up on the encoder board at the same end, and at the same time, just enough for the board to clear the stand-off.
B. Repeat the same process at the other end.
C. Grasp both sides of the encoder board and gently see-saw it up and away from the main keyboard.

The cable from the encoder board, or the keyboard (the cable will be on the main keyboard if you don't have an encoder) is connected to a socket the same as it was on the motherboard end.

Write down the proper cable orientation. This cable can obviously be removed and replaced should the pins of the connector break.

Very rarely will the ribbon break, but the pins, if bent back and forth too many times, will break off. We again caution you to be gentle when removing the cable at either end.

Now that we've taken the computer completely apart, let's see if we can get it back together.

Another word of caution is in store at this point:

If a part is going on too hard or appears to be jamming, you're probably doing it wrong. Take a second look at what you're trying to fit where.

The following will be a step by step instruction guide to reassembling the computer. (This is better then just saying "It goes back together the opposite way you took it apart").

1. First ensure the cable is reconnected to the encoder board, or in the absence of an encoder board. is reconnected to the main keyboard.

Be sure to check cable orientation with the notes you took.

2. If you don't have an encoder board, go to step 3. For those with encoder boards:

A. Turn the main keyboard upside down on a towel or padded surface.

B. Place the encoder board, IC side down toward the back of the main keyboard. The main body of the encoder will be over the main keyboard.
C. Align the 25 pins up with the 25 holes on the connector of the main keyboard.
D. Gently see-saw the pins back into the holes.
E. When all 25 pins are in, press down gently on the encoder until the board locks into the white stand-offs.

At this point, turn the main keyboard face side up. If you can see the IC's of the encoder looking face down onto the keyboard, you've installed it wrong.

When the encoder is installed correctly, you should be able to look face down onto the main keyboard and see a black switch protruding out from the encoder board.

3. Next attach the main keyboard to the housing of the case.

A. Place the housing face down on the towel.
B. Align the keyboard up to the housing so that the cable is closest to the rear of the housing.
C. Attach the keyboard with two screws on each side.

Set the keyboard and housing aside for now.

4. Attach the power supply to the metal bottom plate.

A. Align the supply so that the switch end is at the rear of the bottom plate.
B. Holding the power supply and bottom plate together with one hand, and looking at the bottom of the bottom plate, align the four holes of the power supply up with the four holes of the bottom plate.

C. Attach the supply using the four silver colored phillips head screws.

When done, the colored band of wires coming out from the power supply will be closest to the 45 degree bend of the bottom plate.

5. Attach the motherboard to the bottom plate.

A. Align the board up with the stand-offs of the bottom plate, so that the slots of the motherboard are at the rear of the bottom plate.

B. Gently press the holes of the motherboard onto the stand-offs, working from front to back.

C. If you had to remove four screws at the rear of the motherboard, then you have a metal bar that is to be placed between the motherboard and the bottom plate, at the rear. If you didn't have to remove the four screws, go to step 6.

D. Align the holes of the bar up with the holes of the motherboard and insert the four phillips head screws.

E. If you did not have a silver plate that was removed with the housing and keyboard, then you can tighten the four screws and go to step 6.

F. If you had the silver plate then don't tighten the screws all the way, as you will have to slip the silver plate between the bottom plate and the metal bar.

6. Connect the colored cable from the power supply to the motherboard at location K1.

As stated before, it is keyed so it will only go on one way, and it will lock into place.

7. Connect the wire from the speaker to the motherboard at location B14.

This cable can go on either way.

8. Attaching the housing:

A. Align the housing up to the bottom plate.

B. Lift the housing in front about four inches, and reconnect the cable from the keyboard to the motherboard, at location A7.

C. Double check cable orientation to your notes. The computer gets very upset when this cable is placed in the wrong direction. When placed in properly, the ribbon cable should be going out toward the left side of the motherboard, or toward the letter A.

D. Place the housing back down onto the bottom plate.

E. Grasp the housing and bottom plate, holding them together, and turn the computer upside down on the towel.

F. Reinstall the 10 phillips head screws that hold the housing to the bottom plate.

G. Turn the complete unit face side up again.

9. If you have to disconnect the modulator, reconnect it at location K14. (Black wire closest to the edge of the motherboard.)

10. Before you go any further, double check your work to see if all looks pretty much the same as before you took it apart. Only when you're satisfied, go to step 11.

11. The computer is assembled enough now to do a small power on check.

A. Attach the power cable to the power supply.

B. Attach the monitor cable and/or video cable to the TV and modulator. Remember that the cable goes on to the top of the modulator and not the back.

C. Turn TV set and/or Monitor on.

D. Turn the computer on, and listen for the beep.

IF THERE IS NO BEEP, TURN THE COMPUTER OFF IMMEDIATELY! YOU'VE DONE SOMETHING WRONG! GO TO THE NEXT STEP!

12. If you got a beep in step 11, go to step 13.

A. Having not heard a beep in step 11, obviously you are now petrified. Not to worry, we'll do some quick trouble shooting here. This is of course for those that had a working computer before they took it apart.

B. Analyze what you heard and or saw when you turned the computer on.

C. If you heard the power supply just keep clicking go back and check the power connector at location K1. Ensure it is all the way on the locked into position.

D. Now look at the power light on the keyboard, and very briefly turn the computer on and back off.

E. If the power light came on go to F. If the power light didn't come on, you most likely hooked the cable from the keyboard up backwards. Disassemble the computer again and check it.

F. On the rare occasion that your computer now does not work, and of course it did before you took it apart. You may have blown an IC on the motherboard. Turn the computer on, and the monitor, then go to the trouble-shooting chapter of the motherboard.

13. Now that you've heard the old familiar beep of your computer, and you've breathed a sigh of relief, turn the power switch off and install the boards into their proper slots, and attach the proper cables to same.

CHAPTER 3

Trouble-shooting overview:

The first thing you must do in trouble-shooting a problem in your computer, is to localize the problem down to a specific major section of the complete computer system.

That is to say, if your computer has been working properly right along, and one day breaks down, obviously all the major sections of the computer don't go bad all at once.

Let's take an example:

Computer ALPHA has a computer plus, a green screen monitor, a printer with interface, one disk drive with interface, and a 16K ramcard. This is the complete computer system.

One day computer ALPHA is turned on and nothing happens. No beep, nothing on the screen, no disk drive light, nothing at all happens.

Logical sequence of finding the problem is as follows:

1. First look at the power lights of the system. Is the power light on the keyboard on, the power light on the printer, the power light on the monitor, and so on.

ALPHA has the printer light on, and the keyboard light on, but the monitor light is not on. OOPS we forgot to turn the monitor on.

Turning the monitor on we find the monitor full of strange looking characters. We turn the computer off and back on, and we see the same pattern on the monitor.

2. Second we need to find out if the computer itself is faulty of if one of the boards plugged into the computer is causing the problem.

Turning off the power to the computer and printer, but not the monitor. (We'll need to see the monitor pattern while trouble-shooting.) We remove the lid.

CAUTION:

Never remove a board from your computer or install a board into your computer with the power on! You should always make it a practice to turn off the power of the computer before removing the lid.

Double checking that we have notes on which board goes into which slot, we remove all the boards that are plugged into the slots on the motherboard.

With all the boards out and safely away, we turn on ALPHA. A beep is heard and we see APPLE II with a prompt and flashing curser on the monitor.

We now know one of the boards we removed was causing the problem, as the computer is now responding normally.

3. The next step is to find which board is causing our problem. This is done by:

A. Turn off the power.
B. Install one board in it's proper slot.
C. Turn power back on and check the indications from the computer and the monitor.

We start with ALPHA by turning off the power and installing the 16K ramcard. We turn the computer back on and we get a beep and prompt on the screen. Obviously the problem was not the 16K ramcard.

Next we turn off the power and install the printer board. Turning the computer back on, there is no beep and the problem pattern is back on the monitor. AHAA! the printer board is causing the problem in ALPHA.

4. At this point we will want to double-check and make sure we have found the correct faulty section. This is done by:

A. Turn off the computer.
B. Remove the suspected faulty board.
C. Turn computer back on and check for proper indications from the computer and monitor.
D. Turn off the computer again.
E. Re-install the suspected faulty board.
F. Turn computer back on and see if the problem still exists.
G. Turn computer off and remove faulty board for repair.

The reason for double checking is we may have installed the suspected board wrong or not all the way in the slot. A second check could prove the suspected board is in fact good, and a different board is actually causing the problem.

5. Once we've found the problem board:

A. Turn off the computer.
B. Install all the remaining boards.
C. Turn on the computer and check for proper response from the computer and the rest of the system.

This performs two functions. First it allows us to check that only one board was causing the problem, and second, it allows us to see if the faulty board caused any problems with the rest of the computer system in it's absence.

Since this manual deals only with the computer itself, any boards in your computer, except the motherboard, are outside the scope of this manual. We have plans in the future to write add on manuals for disk drive repair, printer repair, etc.

For now we'll turn our attention to the computer itself.

Let's go back to our original problem with ALPHA, and change the symptoms.

In step 2 we remove all the boards. But this time as we turn on the computer, we still get no beep, and the strange pattern is back on the monitor.

Now we have localized the problem down to the computer itself. Once we know it is the computer causing the problem, we can start trouble-shooting down to a major section of the computer.

In chapter 1 we learned there are four major parts to the computer. They are the case, the keyboard, the power supply, and the motherboard.

If you had two computers, the task of trouble-shooting down to the major part would be much easier. You could just swap out the major parts until the problem disappeared.

Unfortunately most of us don't have two computers. (In fact most of us are still trying to figure out why we paid so much money for the one we have.)

We might have the next best thing though. A friend who has the same computer.

This is called the "Buddy System" and don't be afraid to use it in repairing your computer. Use someone's computer to find the faulty part in your computer, and let them use your computer to find the faulty part in their computer. It can save you both a lot of money in repairs.

Should one person you ask be reluctant, point out the advantages to you both. If they are still reluctant, try someone else. The worst thing anyone can say is no.

If you can't use the buddy system, all is not lost, it just takes a little longer to localize the problem.

At this point we're going to tell you a little more about the major parts in your computer.

Problems with the case.

To date we have never seen a problem arise from a computer case, unless it was smashed or run over by a steam roller. The case itself does not go bad, causing an inoperative computer. So we can concentrate our efforts on the other three parts.

Problems with the power supply.

If you turn your computer on, and you see the power light on the motherboard come on, you can be about 99% sure that the power supply is operating.

When the power supply goes bad, one of two things will occur. Either the light on the keyboard will not glow at all, or you will see the light glow from bright to very dim.

Then and only then suspect a power supply problem, and consult the chapter on the power supply.

Problems with the keyboard.

When the keyboard fails, everything else in the computer will appear normal in almost every case.

A grave exception to this is if you put the ribbon cable from the keyboard to the motherboard back on the wrong way. This will overload the power supply, and make it look like you have a power supply problem, as the keyboard light will not glow.

(If you accidently pull this little trick with the ribbon cable, turn off power immediately, and connect the cable properly. To date we have seen no adverse effect if the problem is corrected right away.)

Keyboard problems vary. Generally you only notice them when you try to type something in on the keyboard.

If you suspect a keyboard problem, consult the chapter on keyboards.

Motherboard problems.

You should be able to see from the above paragraphs that the majority of your computer problems will be caused by the motherboard. In fact about 95% of computer related failures are caused by the motherboard.

The next chapter deals with motherboard trouble-shooting and repair.

The main point we are trying to stress in this chapter is logical trouble-shooting techniques.

In this way you localize the problem first to the computer itself, then localize the problem to the major part of the computer.

CHAPTER 4

Trouble-shooting the motherboard.

Since you now know that most of your problems will occur on the motherboard, this chapter will explain the function of the parts on the motherboard and assist you to localize the problem down to a faulty part or parts.

Once you know the part(s) to replace, you enter your local electronics store and purchase the necessary replacement part(s).

Appendix B lists the IC's of the motherboard and average prices for each part. You will be amazed at how little some of the IC's cost. Which may also make you wonder why repair bills are so high.

You will also see from Appendix B that most of the IC's in your computer are stock parts available from almost any well stocked electronic store. Only 6 or 7 IC's are special, and must be purchased at an authorized Apple repair store.

Let's get a little more familiar with the IC's on the motherboard. You can either look at the parts on your motherboard, or look at the figure 10 page 89, in the Apple II reference manual P/N A2L000 1A.

A1 is a number of small parts that make up what is called the crystal circuitry. It is where everything gets started in your motherboard.

If this area fails generally you will see no video at all and hear no beep. But when the computer is turned on, you will see a momentary flicker on the monitor.

4. Programs load but bomb out after awhile.

5. The computer goes into the wrong graphic mode.

Should you suspect a ram problem, try swapping the RAM chips around. This is really the only area that this is feasible to do.

All the RAM chips are the same. Most computers have 4116 or equivalent. Replacement sets are generally purchased in sets of eight. Average price being $12.00 per set, available from an electronics store.

F3 thru F11 are your ROM chips. ROM stands for Read Only Memory. Aside from the character generator mentioned above, these are the only chips not available from the average electronics store and must be purchased from an Apple repair store.

These ROMs determine whether you have a standard computer or a computer plus.

If you have a standard computer, F3 thru F8 will be filled. F9 will be open, and F11 may or may not have a ROM IC depending on whether you purchase an AID#1 ROM or not.

Incidently, for those with the standard computer, you can change to a computer plus by removing the Integer ROMs you now have in this section and replacing them with a set of six Apple soft ROM chips. You will then have a computer plus instead of a standard computer.

Should any of these ROMS fail it can cause just about as many problems as RAM failure. However, if you can get a power on reset, you will generally notice that assembly language programs will run, but basic programs fail.

Each ROM is different and therefore cannot be swaped like the RAM.

If diagnostics programs are not available, and you can't use the buddy system, the only thing left is replacing the ROMs one by one. This can get rather expensive at $13.50 per ROM.

H7 is the microprocessor chip itself, and the heart of your motherboard. It is a 6502 IC.

Very seldom will this chip ever go bad and you should suspect it last. The replacement cost is about $9.00 from an electronics store.

The balance of IC's are all low cost replacement standard IC chips ranging from .25 to $2.50, the average price being about 50 cents.

While it is almost impossible to list every problem, and every solution, we think the following charts in this chapter will hit over 90% of the failures on the motherboard.

The chart is of course written from the standpoint that a bad IC chip is causing the problem. There are a few other parts on the motherboard, but the IC's are most likely to fail first.

At this point we should point out there are several different revisions of the motherboard. The charts will work on all the revisions except in the following case:

1. The older computers will be missing a couple of parts in the A row. These computers also only generate four colors in the high res modes.

2. The newest revision has a part no. DP8304 IC at location H10 and location H11 has no part. This 8304 is a replacement for the two 8T28 IC's on older revisions.

3. Location 2E on the newer revisions (►REV6) has no IC. This was removed when the memory jumpers were removed at locations 1F, 1E, and 1D.

On older computers this was for use of 4K RAM chips or 16K RAM chips, when RAM was very expensive. (A set of 8 used to cost $300 per set.) As the price dropped rapidly, everyone went to 16K RAMs so the jumpers were no longer needed.

Should you come to the section in the chart that says replace a part in an area, and you don't have a part in that area, just disregard replacing that part.

Trouble-shooting chart:

Problem	Replace IC's at:
Dead computer. No speaker beep. No video indications at all, or just a flicker on the screen when the power switch is turned on. Power light on keyboard is on.	A2, B2, B13 C1, C2 A14 (new rev only)
No video indications at all, or just a flicker of the screen when the power switch is turned on. Speaker does beep. Power light on keyboard is on.	A2, A8, A9, A10 B2, B10, B13 C2, C11 D11, D12, D13 or D14
Screen comes to life but no curser prompt. Screen may be filled with different characters which may or may not change when computer is turned off then back on. Speaker does not beep or may have a raspy sound when power switch is turned on. Power light on keyboard is on. (Note: this problem is the most common in the computer.)	A13 B5, B6, B7, B8 B11 C1, C2, C14 C3 thru C10 D3 thru D10 E3 thru E10. E11 E12, E13 F3 thru F14 H1 thru H5, H8 H10, H11, H14
Screen comes on with wierd looking graphic characters, but no words. Speaker beeps.	A3, A5, A8, A9 A10 B2
No color, everything else works normally.	B12, B13 C13
Screen rolls vertically with or without stopping.	C13, C14 D13 thru D14
Screen characters look like they are crunched, and everything is slanted grossly on the screen. (This is horizontal failure.)	C13, C14 D13 thru D14

Trouble-shooting chart continued:

Trouble-shooting chart:

Problem	Replace IC's at:
Graphic problems. Text mode works fine. All else is normal.	A8 thru A11 B4, B5, B8, B9 B12, B13 C3 thru C10, C12 C14 D3 thru D10 E11 thru E14 F14, H1, J1
Wrong or deformed characters on screen.	A3, A5 B5 thru B8
Abnormal Curser. All else normal.	A3 B2, B3, B11, B13
Speaker doesn't work. All else normal.	F13 K13
Keyboard not working properly, swapping keyboard does not fix problem.	A12 B6, B10 C11 F13
Add on board won't work in one slot. Or works in one slot, but won't work in a different slot.	H2 thru H12
Game paddle problem.	F13 H13, H14
Cassette problem.	F13 H14 K12, K13
Computer has memory retention problem.	C3 thru C10 D3 thru D10 E3 thru E10
General Memory problems may also be caused from:	A2, B5, B8, C1 C2, C11, C12, D2, E2, E11 thru E14 F2, & H1

CHAPTER 5

Trouble-shooting The Power Supply:

As stated previously, you should only suspect a power supply problem, if you turn the computer on and the power light on the keyboard does not light.

Rare power supply problems can also cause the light on the keyboard to dim after a period of use and/or brighten after a period of use.

The same problem will generally be noticed in the use or non-use of the computer as well as seeing the symptom of the power light.

The power supply is a sealed unit that should not be opened by someone with no technical background Even with a technical background, be very cautious as even a dormant power supply can cause hazardous shock.

If the power supply has not been opened, an authorized Apple repair store will trade your bad supply in for a good one, but of course not for free. The present going rate is $90 to $120 for the trade.

Unfortunately Apple, Inc. has sealed their power units with rivets. If these rivets are removed, some repair stores will not honor a trade. In this case the going rate for a new power supply is about $300.

There is one common exception of having to replace the complete power supply that you should be aware of. The power switch itself on older computers frequently breaks.

This applies to power supplies with the Rocker II switch. These can be identified by looking at the switch itself. If the ON/OFF letters are on the rocker part itself (the part of the switch you move) then it is a Rocker II switch. If the ON/OFF letters are above the below the rocker part, then it is a Rocker I switch.

Symptoms of a bad Rocker II switch are:

1. No snap at all to the switch, it rocks back and forth with no resistance at all.

2. It's jammed in one position either on or off.

3. You feel more then one click when pushing the rocker in either the on or off position.

If the Rocker II switch breaks in the on position, where contant power is applied to the computer, you can:

1. Purchase a Super Fan or System Saver Fan that hangs on the side of the computer. Both these fans have a power switch that can be used as an alternate to the computer power switch.
2. You can buy a power strip that has a power switch from almost any electronics store, and use that to supply electricity to the computer.

In either case, this method will be less expensive then replacing the power supply itself.

If the Rocker II switch breaks in the off position, you can acquire the switch alone from an authorized Apple repair store (part no. 705-0001), then hire an electronic repair store or a technically competant person to replace the switch. The switch price is about $2.50.

The switch replacement can be done without taking the power supply apart as follows:

1. Remove power cable trom power supply.
2. Remove power supply from main computer.
3. Pry out bad supply with a flat blade screwdriver.
4. Taking note as to which wires go on which connectors of the switch, unsolder the two wires attached to the switch.
5. Solder the two wires to the new switch.
6. Press the new switch into position on the power supply.

Other then the power supply switch, we recommend form a non-technical stand point, to swap a bad supply for a good one at your local authorized repair store.

CHAPTER 6

Trouble-shooting The Keyboard:

Apple, Inc. has used several different keyboards in their computers. However, they all boil down to two types. Those with external encoder boards and those without encoder boards.

If you look inside the computer directly beneath the main keyboard itself, and see a small pc board (about 4 inches in length) hanging below the main keyboard, then you have an external encoder board. If you are missing this small board, then your keyboard has all the encoding built into the main keyboard. Only the real old computers will be missing the external encoder board.

The encoder board takes the information you type in on the keyboard and converts it into information the motherboard can understand.

Let's first try to diagnose what type of problem we are having with the keyboard. Of course we have diagnosed the problem in the computer down to the keyboard at this point.

There are generally two rules for diagnosing problems with keyboards. They are simple and about 95% accurate.

1. If the keyboard is for the most part operating normally but one or two keys stick or won't display the character when pressed, then the problem will be in those keys alone.

2. If multiple keys are presenting problems, displaying wrong character, not displaying anything at all, or displaying a full line or two of one character, when the key is pressed just once, the problem will be in the encoding section or the external encoder board.

Now for the repair:

Two major companies have produced the main keyboard for Apple, Inc. They are DATANETICS and THE KEYBOARD COMPANY (TKC). You can find the manufacturer of your keyboard by turning the main keyboard upside down and looking at the underside. The name will be imprinted on the PC board.

Datanetics produced keyboards with and without external encoder boards. TKC produced only the keyboards with external encoders.

Datanetics repair main keyboard:

1. Each key has a key switch that is seperately soldered to the main keyboard PC and held in by a screw. If only one or two keys need replacement, you can purchase the key switches from an authorized Apple repair store, then find an electronic repair store or competant technician to replace them. The process is simple and as follows:

   A. Unsolder the two contacts of defective key switch.
   B. Remove holding screw for switch.
   C. Switch will lift out.
   D. Place new switch into position.
   E. Replace holding screw.
   F. Solder the two contacts of the switch.

Datanetics repair no external encoder.

You will notice on the main keyboard a large 40 pin chip in a socket. This is a 5470 encoder IC chip and there is no replacement for it. One of the reasons Apple, Inc. went to the external encoder board was because this chip is no longer manufactured.

When and if this chip does go out, your authorized Apple repair store has a policy to swap keyboards, yours for one with an external encoder. Of course this swap is not for free, the exchange is about $125.

The other IC's are soldered on the main PC itself and not in sockets. This makes replacement difficult, but not impossible. For about $3.00 you can purchase the IC's, along with sockets, then find a competent technician to replace them.

Datanetics and TKC repair external encoder board.

The encoder board has five IC chips. One 40 pin chip in a socket, which is the encoder chip itself, and four other IC's soldered directly to the encoder board.

It is rather difficult from a non-technical aspect to trouble-shoot a board with the chips soldered in. However let us state that to date it has been our experience that either one of the two 74LS00 IC's will go bad, or the encoder (40 pin chip) will go bad.

The encoder chip can be purchased from an authorized Apple repair store for about $12.00. The balance of the IC's can be purchased with sockets from any electronics store for about $3.00. The encoder chip anyone can replace because it is in a socket. However, the balance of the IC's will have to be replaced by a competant technician.

As a last resort, you can exchange your bad encoder board for a good one at an authorized Apple repair store for about $50.00.

TKC repair main keyboard.

We have seen two styles of main keyboards manufactured by TKC. Those with individual key switches soldered to the main PC and those with mechanical contact not soldered.

To identify which type you have, turn the keyboard upside down to examine the bottom of the PC. If you see silver pads soldered in pairs all over the board, then yours has individual key switches. In the absence of these silver pads will be about 19 phillips head screws, this style has key switches that are obviously not soldered.

If you have individual key switches soldered in, they can be replaced almost in the same way as the Datanetics key switches (explained previously) except there is no holding screw and the switches are a little trickier to remove.

Problems in the keyboards with unsoldered switches stem most of the time from the key being pressed too hard. This will cause the contact to bend too far, and when the key is pressed, will not make electrical contact.

Repair of this keyboard is extremely tricky and should not be performed by those without mechanical aptitude. That being said:

A. Turn keyboard upside down on a flat surface.
B. Remove all phillips head screws.
C. Lift PC (carefully) with contact paper plate.
D. Bend offending key back into shape, conforming with surrounding keys.
E. Place PC back into place.
F. Re-install the phillips head screws.

As a final note to keyboard problems and frustrations the whole keyboard can be exchanged as a last resort. The exchange is about $100.

CHAPTER 7

Final words:

We hope this manual has given you some insight into the repair of your computer. It is impossible to cover the scope of 100% of the problems you may encounter. However, this manual should get you through the majority of the problems and assist you in lowering the cost of repairs.

Data-Line will be sending out periodical updates to this manual as new information arises. Any comments, suggestions, or information you wish to impart to us and/or others should be sent to:

Data-Line
2961 S. Las Palmas
Mesa, Arizona 85202

For those who do not want to do the troubleshooting on their computers, or major parts of the computer, Data-Line has the facilities for troubleshooting and repair.

For stock computers made by Apple, Inc., we charge as follows:

Motherboard repairs.	
Stock Apple	$35 plus parts.
Non-Stock Apple	$35 per hour plus parts.

Note: Wrap Motherboard in foil before sending.

Keyboard repairs.	
Datanetics key switch replacement	$35 plus $2.50 per keyswitch (Limit 5 keyswitches.)

Datanetics (no encoder board) We can only replace the four soldered IC's.	$38
TKC key switch replacement, solder type	Same as above for Datanetics.
TKC key switch repair, non solder type	$45
Encoder board repair. We will place all IC's into socket for additional $3.00.	$35 plus parts.

Note: On Datanetics without encoder boards, send wrapped in foil. All encoder boards should be wrapped in foil.

Power supply repair.

The only thing we will repair on your power supply is a defective switch. However, we replace all switches with a heavy duty rocker switch which involves taking the supply apart to make a larger hole for such switch. Charge is $40.

Instructions:

1. Write down on a sheet of paper what you find wrong with the part you are sending.

2. Write down exactly what you want us to do with the parts you are sending.

3. Send no money. We will return the parts repaired C.O.D. for the above listed charges, plus shipping.

4. When you ship any parts, make sure you insure them against loss.

5. Motherboards, encoder boards, and keyboards with encoding parts on them should all be wrapped in foil, and cushioned for protection during shipment.

6. We accept no purchase orders for repairs.

Non-stock motherboards include: Apple boards you built yourself. Pineapple. Golden. and Apollo boards. Since we can't be sure of an original working condition, we charge $35 per hour.

APPENDIX A

The following is a list of a few mail order electronic firms we highly recommend for electronic repair parts.

1. JDR Microdevices, Inc.
   1224 S. Bascom Ave.
   San Jose, CA 95128
   (800) 538-5000 (orders outside CA)
   (800) 662-6279 (orders inside CA)
   (408) 995-5430 (information)

Price list available. $10 minimum order.

2. Jameco Electronics
   1355 Shoreway Road
   Belmont, CA 94003
   (415) 592-8097

Catalog available. $10 minimum order.

3. Quest Electronics
   P.O. Box 4430X
   Santa Clara, CA 95054
   (800) 538-8196 (orders)
   (408) 988-1640 (information)

Catalog available. $5 minimum order.

Note: Data-Line has no affiliation with the above listed firms nor do we receive any compensation for listing same. All three have always handled our orders promptly, the parts have been reliable, and the prices are competitive.

APPENDIX B

The following is a list of IC chips on the motherboard, and the average range for replacement cost.

LOCATION	PART	PRICE RANGE	
A2	74LS00	.25 - .35	
A3	74166	1.00 - 1.25	
A5 REV6◄	2513	8.95 - 9.95	
A5 REV7►	341-0036-00 (SEE ROM SECTION)		
A8	74LS257	.60 - .90	
A9	74LS151	60 - .90	
A10	74LS194	.70 - 1.20	
A11	74LS74	.35 - .45	
A12	74LS02	.25 - .35	
A13	NE555	.35 - .45	
A14	74LS02	.25 - .35	
B1	74S175	95 - 1.60	
B2	74S86	.50 - .80	
B3	NE555	.35 - .45	
B4	74LS194	.70 - 1.20	
B5	74LS174	.60 - 1.00	
B6	74LS257	.60 - 90	
B7	74LS257	.60 - .90	
B8	74LS174	.60 - 1.00	
B9	74LS194	.70 - 1.20	
B10	74LS74	.35 - .45	
B11	74LS08	.30 - .45	
B12	74LS11	.35 - .45	
B13	74LS02	.25 - .35	
B14	74LS02	.25 - .35	
C1	74LS153	.55 - .90	
C2	74S195	1.50 - 2.00	
C3-C10	4116 DYNAMIC RAM	1.00 - 1.50	EACH
C11	74LS04	.25 - .35	
C12	74LS257	.60 - .90	
C13	74LS51	.25 - .35	
C14	74LS32	.30 - .40	
D2	74LS20	.25 - .35	
D3-D10	4116 DYNAMIC RAM	1.00 - 1.50	EACH
D11	74LS161	.65 - .90	
D12	74LS161	.65 - .90	
D13	74LS161	.65 - .90	
D14	74LS161	.65 - .90	
E2	74LS139	.60 - .90	
E3-E10	4116 DYNAMIC RAM	1.00 - 1.50	EACH

LOCATION	PART	PRICE RANGE
E11	74LS153	.55 - .90
E12	74LS143	.55 - .90
E13	74LS153	.55 - .90
E14	74LS283	.70 - .90
F2	74LS139	.60 - .90
F3-F11	ROMS (SEE ROM SECTION)	
F12	74LS138	.60 - .90
F13	74LS138	.60 - .90
F14	9334 (74259)	2.50 - 2.95
H1	74LS08	.30 - .35
H2	74LS138	.60 - .90
H3	8T97 (74LS367)	.50 - 1.65
H4	8T97 (74LS367)	.50 - 1.65
H5	8T97 (74LS367)	.50 - 1.65
H7	6502	5.95 - 9.00
H10 ◄REV8	8T28	1.95 - 2.50
H10 REV8	DP8304	3.50 - 4.50
H11	8T28	1.95 - 2.50
H12	74LS138	.60 - .90
H13	NE558	1.50 - 2.50
H14	74LS251	.60 - 1.00
J1	74LS257	.60 - .90
J13	74LS74	.35 - .45
K13	MC741	.35 - .40

ROMS

INTEGER	F8	341-0004-00	13.50
INTEGER	F0	341-0003-00	13.50
INTEGER	E8	341-0002-00	13.50
INTEGER	E0	341-0001-00	13.50
INTEGER	D0	341-0016-00	48.00
SOFT	F8	341-0020-00	13.50
SOFT	F0	341-0015-00	13.50
SOFT	E8	341-0014-00	13.50
SOFT	E0	341-0013-00	13.50
SOFT	D8	341-0012-00	13.50
SOFT	D0	341-0011-00	13.50
A5	►REV7	341-0036-00	18.00

APPENDIX C

The following is a list of magazines we recommend:

CALL-A.P.P.L.E.
304 Main Ave. S., Suite 300
Renton, WA 98055
(206) 271-4514

This is an Apple users club that publishes one of the best magazines for the Apple.
They also have a diagnostic disk available to members called Aptest for $18.50.

One time Apple-cation Fee	$25.00
Annual dues	20.00

NIBBLE
Box 325
Lincoln, MA 01773
(617) 259-9710

Magazine devoted to Apple alone.
Annual subscription rate $20.00.

SOFTALK
11021 Magnolia Blvd.
North Hollywood, CA 91601
(213) 980-5074

Magazine devoted to software for the Apple alone.
Annual subscription rate $24.00.

HARDCORE COMPUTING
P.O. Box 44549
Tacoma, WA 98444
(206) 531-1684

Magazine devoted to breaking the locks off protected software.
Annual subscription rate $20.00.

COMPUTER SHOPPER
P.O. Box F
Titusville, FL 32780
(305) 269-3211

This is a nation wide newspaper for buying and selling all types of computers including Apple.
Annual subscription rate $10.00.